I. *An Account of Obſervations made on Board the* Chatham-Yacht, Auguſt 30*th and* 31*ſt, and* September 1*ſt*, 1732, *in purſuance of an Order made by the Right Honourable the Lords Commiſſioners of the Admiralty, for the Trial of an Inſtrument for taking* Angles, *deſcribed in* Philoſophical Tranſactions, *Numb*, 420. *By* John Hadley, *Eſq; Vice-Preſident of the* Royal Society.

IN *May*, 1731, I communicated to the *Society* the Deſcription of a new Inſtrument for taking Angles, and produced a Specimen of an Inſtrument made accordingly. Several of the Gentlemen to whom it was ſhewn, as well then as at other times, entertained a favourable Opinion of the Probability of its Uſefulneſs, particularly our worthy Vice-Preſident Dr. *Edmund Halley*, Aſtr. Reg. and the Reverend Mr. *James Bradley*, Aſtr. Pr. S. not only expreſſed their Deſire that Trial ſhould be made of it at Sea, but promiſed the Favour of their Company and Aſſiſtance on that Occaſion.

The Inſtrument produced at the *Society* was made of Wood, according to *Fig.* IV. *Tranſact.* N° 420. of the 'forementioned Deſcription, and was intended chiefly for taking Altitudes of the Sun, Moon and Stars, from the viſible Horizon, either forwards or backwards; I therefore procured another to be made of Braſs by Mr. *J.*

Siſſon, for taking the Diſtance of any kind of Objects. It is ſupported by a ſingle Stem ſkrewed on to it on the under Side, the lower End of which may reſt on the Ground, to eaſe the Obſerver of the Weight of the Inſtrument. This Stem is alſo made to lengthen or ſhorten, by which Means the Inſtrument is brought to the proper Height for any Obſerver's Eye, either ſtanding or ſitting. Inſtead of a Ball and Socket, it has two circular Arches fixed on its Back, by which it is readily ſet to any Poſition which the Situation of the Objects may require.

The Right Honourable the Lords Commiſſioners of the Admiralty having been pleaſed to order the *Chatham-Yacht* for the Trial of the ſaid Inſtrument, and to give Directions to Mr. *James Young*, Maſter Attendant at *Chatham*, a Gentleman well ſkill'd in Navigation, to be preſent at the Trial, my two Brothers and Self went on Board accordingly *Wedneſday*, *Auguſt* the 30th, being favoured with the Company (beſides the two 'forementioned Gentlemen) of the Reverend Sir *Robert Pye*, Bart. and *Robert Ord*, Eſq; Members of this *Society*. We met Mr. *Young* at *Sheerneſs* the next Day, who accompanied us down about three Leagues below the *Nore*, near the *Spile-Sand*, and was on Board on *Friday*, *September* the 1ſt, when we lay by there, and the ſeveral Altitudes of the Sun were taken as it approached the Meridian from about Ten of the Clock 'till Noon.

The

The Obſervations were as follow.

Auguſt the 30th, near Midnight, Mr. *Bradley* obſerved the Diſtance of *Lucida Lyræ* from *Cor Aquilæ* by the Braſs Inſtrument off *Graveſend* in ſtill Water, 34° 13′ 30″

The ſame repeated was 34 13 15

The Error of the Inſtrument in that Place is 23″ to be ſubtracted.

The Diſtance of thoſe Stars, according to Mr. *Flamſteed*, is 34° 11′ 50

Which by the Refraction is reduced to 34 11 10

Auguſt the 31ſt, about 10ʰ 30′, Mr. *Bradley* obſerved the Diſtance of *Capella* from the *North Pointer* in the *Great Bear's* Back, by the ſame Inſtrument, while we lay at Anchor in the Mouth of the *Medway* near *Sheerneſs*, the Wind blowing hard at North Eaſt, 49° 14′ 00″+

Or 49 15 00

Mr. *Bradley* and my ſelf making a ſmall Difference in numbring the Angle mark'd by the Index.

The Error of the Diviſion of the Inſtrument there is 30″ to be added.

The Diſtance of thoſe Stars, according to Mr. *Flamſteed*, is 49° 16′ 00″

By the Refraction reduced to 49 14 20

Clouds coming up prevented the repeating this Obſervation, nor had we any Opportunity of making any others of this kind.

Altitudes of the Sun observed by Mr. *Bradley*, lying at Anchor in the Mouth of the *Medway*, *August* the 31st, Afternoon, the Wind at North-East, a fresh Gale, by the Wooden Instrument forwards. The Watch by the Mean of the Observations appeared to be about 8′ 45″ too slow; the visible Horizon being supposed 3′ 30″ depressed below the true by the Height of the Observer's Eye above the Surface of the Water, amounting to about 8 or 9 Feet.

Time by Watch.			True Time.			True Alt. of Sun's upper Limb from the visible Horizon.			Refraction, add.		Appt Alt. of Sun's upper Limb from the visible Horizon.			Alt. of the Sun's upper Limb observed.			Errors of Division of the Instr. Substr.		Observed Alt. of the Sun's upper Limb corrected.			Errors of Observation.	
h	′	″	h.	′	″	°	′	″	′	″	°	′	″	°	′	″	′	″	°	′	″	′	″
5	11	50	5	20	35	9	50	31	4	54	9	55	25	9	57	00	2	15	9	54	45	−0	40
	16	30		25	15		07	00	5	17		12	17		13	30	2	15		11	15	−1	02
	18	20		27	05	8	49	52	5	27	8	55	19	8	57	30	3	00	8	54	30	−0	49
	21	20		30	05		21	51	5	44		27	35		30	00	3	00		27	00	−0	35
	28	5		36	50	7	18	44	6	28	7	25	12	7	27	30	2	00	7	25	30	+0	18
	30	35		39	20	6	55	22	6	46		02	08		05	00	2	15		02	45	+0	37
	32	25		41	10		38	13	7	03	6	45	16	6	48	00—	2	15	6	45	45—	+0	29—
	36	30		45	15		00	00	7	40		07	40		10	00	2	15		07	45	+0	05
	38	37		47	22	5	40	11	8	03	5	48	14	5	51	00	2	15	5	48	45	+0	31
	40	35		49	20		21	50	8	24		30	14		34	00—	2	15		31	45—	+1	31—
	42	34		51	19		03	14	8	50		12	04		15	00	3	00		12	00	−0	04
	43	50		52	35	4	51	24	9	07		00	31		03	30	3	00		00	30	−0	1

Altitudes

Altitudes of the Sun, obſerved *September* the 1ſt, before Noon, under Sail from *Sheerneſs* towards the *Spile-Sand*, with the Tide of Ebb, the Wind blowing hard at North-Eaſt, by the Wooden Inſtrument forward. The ſecond Speculum being removed by ſome Accident from its due Poſition, ſo as to increaſe the Angles obſerv'd about one Degree three Minutes and a half, as appeared by the firſt Obſervations of the Afternoon of the ſame Day, made with the ſame Inſtrument, in the ſame manner, while we continued lying by near the *Spile*; and that Degree and three Minutes and a half are added to the Errors of the Diviſions of the Inſtrument in the ſeventh Column. While theſe Obſervations were making, the Yacht ſteered at firſt chiefly Eaſt, ſometimes South-Eaſt, afterwards ſtood to the North-Eaſt, towards the *Swin*. The Time of the Watch was regulated by ſome of the later Obſervations made when we were moſt Eaſtward, and this was probably the Cauſe why the firſt Altitudes, which were taken while we were more Weſterly, fall ſo much ſhort of the Computations, the Difference decreaſing gradually as we advanced towards the Eaſt.

Altitudes

Altitudes obſerved by Mr. *Bradley*.

Time by Watch.	True Time.	True Alt. of the Sun's lower Limb from the viſible Horizon.	Refraction, add.	Appt Alt. of the Sun's lower Limb from the viſible Horizon.	Altitude of the Sun's lower Limb obſerved.	Errors of the Inſtrument ſubſtract.	Obſerved Altitude of the Sun's lower Limb corrected.	Errors of Obſervation.
h. ′ ″	h. ′ ″	° ′ ″	′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	′ ″
7 09 15	7 18 15	15 05 39	3 15	15 08 54	16 09 00	1 5 45	15 03 15	−5 39
11 44	20 44	28 13	3 11	31 24	33 00−	1 5 45	27 15−	−4 09+
13 38	22 38	45 23	3 08	48 31	49 00	1 5 45	43 15	−5 16
14 53	23 55	56 43	3 05	59 48	17 02 00	1 5 45	56 15	−3 33
16 33	25 33	16 11 47	3 02	16 14 49	18 00−	1 5 45	16 12 15−	−2 34+
18 04	27 04	25 31	2 59	28 30	32 00	1 5 45	26 15	−2 15
23 54	32 54	17 18 00	2 50	17 20 50	18 25 00	1 6 30	17 19 30	−1 20
25 38	34 38	33 31	2 47	36 18	43 00+	1 6 00	37 00+	+0 42+
28 25	37 25	58 23	2 43	18 01 06	19 07 00−	1 6 00	18 01 00−	−0 06+
30 44	39 44	18 19 04	2 40	21 44	28 00	1 5 00	23 00	+1 16
34 21	43 21	51 10	2 35	53 45	20 00 00	1 4 30	55 30	+1 45
36 24	45 24	19 09 18	2 33	19 11 51	16 00	1 4 30	19 11 30	−0 21
38 44	47 44	29 54	2 30	32 24	38 00−	1 4 30	33 30−	+1 06—uncertain
40 30	49 30	45 27	2 28	47 55	52 00+	1 4 30	47 30+	−0 25−
42 00	51 00	58 41	2 26	20 01 07	21 04 00+	1 4 30	59 30+	−1 37−
45 34	54 34	20 29 51	2 22	32 13	35 00	1 4 30	20 30 30	−1 43

The same continued by Mr. *John Hadley*.

Time by Watch.	True Time.	True Alt. of the Sun's lower Limb from the visible Horizon.	Refraction, add.	Appt Alt. of the Sun's lower Limb from the visible Horizon.	Altitude of the Sun's lower Limb observed.	Errors of the Instrument substract.	Observed Altitude of the Sun's lower Limb corrected.	Errors of Observation.
h. ′ ″	h. ′ ″	° ′ ″	″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	′ ″
7 52 18	8 01 18	21 28 21	2 15	21 30 36	22 36 00—	1 4 30	21 31 30—	+0 54—
54 18	03 18	45 43	2 13	47 56	52 00	1 4 30	47 30	−0 26
55 40	04 40	57 25	2 12	59 37	23 04 00	1 4 30	59 30	—0 07
58 22	07 22	22 20 34	2 09	22 22 43	30 00	1 5 15	22 24 45	+2 02 uncertain.
8 02 51	11 51	58 46	2 06	23 00 52	24 04 00	1 5 15	58 45	—2 07
09 19	18 19	23 53 26	2 00	55 26	25 00 00+	1 5 30	23 54 30+	—0 56—
13 10	22 10	24 25 35	1 57	24 27 32	32 00	1 5 30	24 26 30	—1 02
14 45	23 45	38 43	1 56	40 39	45 00+	1 5 30	39 30+	—1 09—
16 55	25 55	56 24	1 55	58 19	26 03 00	1 5 30	57 30	—0 49
19 05	28 05	25 14 34	1 53	25 16 27	22 00+	1 5 30	25 16 30+	+0 03+
22 57	31 57	46 14	1 51	48 05	52 00—	1 5 30	46 30—	—1 35+
25 05	34 05	26 03 35	1 49	26 05 24	27 10 00—	1 5 30	26 04 30—	—0 54+
26 43	35 43	16 50	1 48	18 08	22 00+	1 5 30	16 30+	—1 38—
28 20	37 20	29 54	1 47	31 41	35 00	1 5 30	29 30	—2 11

Altitudes

Altitudes of the Sun, obſerved lying-by near the *Spile*, *September* the 1ſt, before Noon, with the Wooden Inſtrument backward, the Wind continuing to blow hard, as before, at North-Eaſt. The Inſtrument when uſed for the back Obſervation was ſo adjuſted, as to allow for a Dip of the viſible Horizon of two Minutes and a half; conſequently that Dip being ſuppoſed, as before, three Minutes and a half, there remains only one Minute to be accounted for, in computing the Height of the Sun, which is accordingly ſubtracted in the third Column from the Altitudes found by Computation. The Watch now appeared to be 9′ 30″ too ſlow.

Altitudes obſerved by Mr. *John Hadley*.

Time by Watch.			True Time.			True Alt. of the Sun's upper Limb.			Refraction, add.		Appt Alt. of the Sun's upper Limb.			Alt. of the Sun's upper Limb obſerved.			Errors in the Diviſion. Subſtr.		Obſerved Altitude of the Sun's upper Limb corrected.			Errors of Obſervation.	
h.	′	″	h.	′	″	°	′	″	′	″	°	′	″	°	′	″	′	″	°	′	″	′	″
9	52	55	10	02	25	36	52	54	1	11	36	54	05	36	46	00	1	00	36	45	00	−9	05
10	02	07		11	37	37	43	37	1	09	37	44	46	37	44	00	1	00	37	43	00	−1	46
	06	00		15	30	38	04	00	1	08	38	05	08	38	04	00	1	00	38	03	00	−2	08
	08	53		18	23		19	00	1	08		20	08		22	00+	1	00		21	00+	+0	52+
	12	25		21	55		36	25	1	07		37	32		41	00	1	30		39	30	+1	58
	16	30		26	00		56	09	1	06		57	15	39	00	00	1	30		58	30	+1	15
	18	50		28	20	39	07	07	1	06	39	08	13		06	00	0	30	39	05	30	−2	43
	20	40		30	10		15	26	1	06		16	32		14	00	0	30		13	30	−3	02

The same continued by Mr. *Bradley*.

Time by Watch.	True Time.	True Alt. of the Sun's upper Limb.	Refraction, add.	Appt Alt. of the Sun's upper Limb.	Alt. of the Sun's upper Limb observed.	Errors in the Division. Substr.	Observed Altitude of the Sun's upper Limb corrected.	Errors of Observation.
h. ′	h. ′ ″	° ′ ″	′ ″	° ′ ″	° ′ ′	′ ″	° ′ ″	
10 30 18	10 39 48	39 57 28	1 04	39 58 32	40 00 00	2 00	39 58 00	−0 32
33 23	42 53	40 10 02	1 04	40 11 06	12 00	2 00	40 10 00	−1 06
35 53	45 23	19 51	1 04	20 55	16 00−	2 00	14 00−	−6 55+
37 48	47 18	27 13	1 03	28 16	32 00−	2 30	29 30−	+1 14−
39 22	48 52	33 03	1 03	34 06	36 00	2 30	33 30	−0 36

Continued yb Mr. *Henry Hadley*.

11 08 05	11 17 35	41 59 36	1 00	42 00 36	42 15 00+	2 30	42 12 30−	+11 54+
16 20	25 50	42 16 36	1 00	17 36	20 00	2 30	17 30	−00 06
22 00	31 30	25 48	0 59	26 47	31 00	2 45	28 15	+01 28
24 20	33 50	29 35	0 59	30 34	34 00	2 45	31 15	+00 41
28 00	37 30	34 27	0 59	35 26	39 00	2 45	36 15	+00 49
33 45	43 15	40 32	0 58	41 30	45 00−	3 00	42 00−	+00 30−
37 45	47 15	43 43	0 58	44 41	48 00+	3 00	45 00+	+00 19+
40 30	50 00	45 25	0 58	46 23	49 00	3 00	46 00	−00 23
43 00	52 30	46 34	0 58	47 32	51 00	3 00	48 00	+00 28
47 00	56 30	47 42	0 58	48 40	52 00	3 00	49 00	+00 20
again.					52 00	3 00	49 00	+
again.	12 00 00	48 02	0 58	49 00	52 00	3 00	49 00	00 00

Between each of the five last of these Observations the Index was removed so as to make them entirely independent of one another; and from their near Agreement among themselves, and with good Part of the preceding, I conclude the true

Height of the Sun's Center above the real Horizon at Noon was exactly enough 42° 33′ his Semidiameter being 16 Min. from which, and the Sun's Declination 4° 1′ the Latitude of the Place will be 51° 28′, which is accordingly uſed in all the Computations.

Altitudes of the Sun obſerved *September* 1, 1732, Afternoon, near the *Buoy of the Spile*, and under Sail Weſtward, by the Wooden Inſtrument forwards, the ſecond Speculum remaining diſplaced as in the Morning.

Altitudes obſerved by Mr. *Bradley*.

Time by Watch.	True Time.	True Alt. of the Sun's lower Limb from the viſible Horizon.	Refraction, add.	App^{t} Alt. of the Sun's lower Limb from the viſible Horizon.	Altitude of the Sun's lower Limb obſerved.	Errors of the Inſtrument ſubſtract.	Obſerved Altitude of the Sun's lower Limb corrected.	Errors of Obſervation.	
h. ′ ″	h. ′	° ′ ″	′ ″	° ′ ″	° ′ ″	° ′ ″	° ′ ″	′ ″	
12 07 30	12 17 00	42 12 13	1 00	42 13 13	43 20 00	1 6 0	42 14 00	+0 47	
08 30	18 00	11 09	1 00	12 09	19 00	1 6 0	13 00	+0 51	
12 00	21 30	07 18	1 00	08 18	13 00	1 6 0	07 00	−1 18	
19 50	29 20	41 56 00	1 00	41 57 00	01 00	1 6 0	41 55 00	−2 00	

The ſame continued by Mr. *Henry Hadley*.

1 00 00	1 09 30	40 09 21	1 03	40 10 24	41 13 00	1 6 0	40 07 00	−3 24	uncertain
01 35	11 05	03 20	1 04	04 24	10 00	1 6 0	04 00	−0 24	
03 02	12 32	39 57 59	1 04	39 59 03	04 00	1 6 0	39 58 00	−1 03	
04 21	13 51	52 57	1 04	54 01	02 00	1 6 0	56 00	+1 59	
06 14	15 44	45 31	1 04	46 35	40 52 00	1 6 0	46 00	−0 35	
07 30	17 00	40 28	1 04	41 32	49 00	1 6 0	43 00	+1 28	
08 43	18 13	35 37	1 05	36 42	40 00	1 6 0	34 00	−2 42	uncertain
10 00	19 30	30 28	1 05	31 33	38 00	1 6 0	32 00	+0 27	
11 29	20 59	24 22	1 06	25 28	34 00	1 6 0	28 00	+2 32	
14 23	23 53	11 46	1 06	12 52	18 00	1 6 0	12 00	−0 52	

The firſt and ſixth Columns of the preceding Tables of Obſervations are copied from the Minutes as they were ſet down at the Time. The Diviſions of the Wooden Inſtrument being not exact, I found it neceſſary to make a Table to correct them by, which was done partly by meaſuring with Compaſſes, and partly by examining them againſt thoſe of another Inſtrument. The Corrections are every where to be ſubſtracted from the Angles obſerved, and the Errors of a Degree and three Minutes and a half, occaſioned by the miſplacing the ſecond Speculum in all the forward Obſervations of *September* the 1ſt, being of the ſame kind, are joined with them, in the ſeventh Column of the Tables of thoſe Obſervations. The laſt Column contains the Differences between the obſerved Altitudes, corrected by the 'forementioned Table, and the Altitudes as they ought to have appeared by the Computations. Among them there are two or three which ſo much exceed any of the reſt, that for that reaſon they ſeem to be rather owing to Miſtakes, in counting the Minutes on the Inſtrument, or the Time by the Watch, than to the Errors of the Obſervations.

The greateſt Part of the Altitudes were taken by a Horizon not clear of Land, and by that Means not always ſo readily diſtinguiſhable. The Obſervers were all Perſons quite unaccuſtomed to the Motion of a Ship at Sea, which in this Caſe was generally very great and quick, the Veſſel we were in being only of about 60 Tuns Burthen, as the Maſter informed us, the ſmallneſs of which made it alſo more liable to be lifted up and let down again by the Waves: And if the Difference of Height occaſioned by that Means was about four or five Feet, as we judged it to be, it

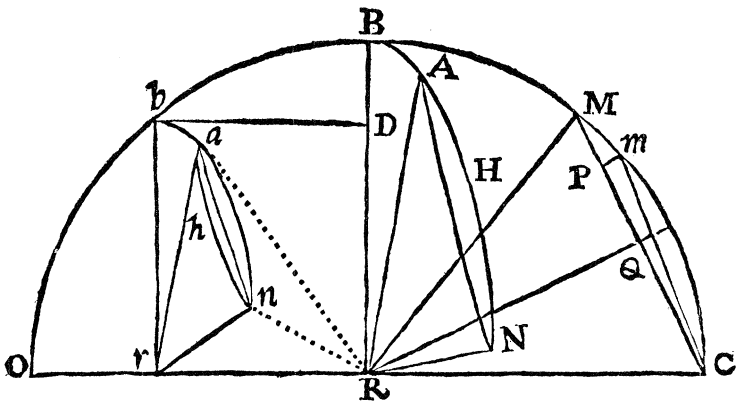
muſt neceſſarily ſink and raiſe the viſible Horizon by Turns near one Minute. The Computations of the Sun's Altitudes are all made for the Latitude of 51° 28', whereas a good Part of them were taken under Sail, and upon different Tacks, the Veſſel ſometimes ſtanding North Eaſt or North, and at other times South Eaſt, for near a quarter of an Hour at a time.

Several of theſe Circumſtances may probably have contributed to increaſe the Inconſiſtency of the Obſervations; but as no particular Notice was taken of them at the Time, I content my ſelf with barely mentioning them.

POSTSCRIPT.

The Principle on which the Contrivance of this Inſtrument depends, was laid down in the before-mentioned *Philoſ. Tranſ.* Numb. 420. in one Propoſition, and ſeveral *Corollaries*, the fifth of which contains the Grounds of an Approximation for correcting ſome ſmall Errors which will ariſe if the Plane of the Inſtrument be ſuffered to vary too much from the great Circle paſſing through the two Objects, when the Obſervation is taken. There appears reaſon to think, that there will be very little Occaſion in Practice for that Correction; but it was neceſſary to mention it, in order to explain the Nature of the Inſtrument; and as the manner of deducing that Corollary from the Propoſition may not appear obvious to every Reader, I have here annexed the Demonſtration of it.

Let



Let O B C in the annexed Figure repreſent an infinite Sphere, at whoſe Center R are placed the two Specula inclined to one another in any given Angle, and let their common Section coincide with the Diameter O R C. Let B A N be the Circumference of a great Circle, to the Plane of which the common Section of the Specula O R C is perpendicular, and B R its Radius: Let *b a n* be the Circumference of a Circle parallel to B A N, and at the Diſtance from it B *b*: Draw *b* D the Sine, and *b r* the Sine complement of the Arch B *b*: B D is the verſed Sine of the ſame. Let A be a Point of an Object placed in the Circumference of the great Circle B A N, and N the Point in which its Image is formed by the two ſucceſſive Reflections, as before deſcribed; and let *a* be a Point of another Object placed any where in the Circumference of the Parallel *b a n*, and *n* its Image; and let *a h n* be an Arch of a great Circle paſſing through the Points *a* and *n*. The Point *a* is at the ſame Diſtance from the great Circle B A N, as the Point *b*,

i. e.

i. e. at the Diſtance B *b*. Draw A R, A N, R N, *a r*, *a n*, *r n*, *a* R and *n* R.

By the fourth Corollary the Figures A R N and *a r n* are ſimilar, and conſequently the Line A N is to the Line *a n* as A R or B R is to *a r* or *b r*, *i. e.* as the Radius is to the Sine complement of the Diſtance B *b*. But A N is the Chord of the Arch A H N of the great Circle B A N equal to the Tranſlation of the Point A, or double the Inclination of the Specula, and *a n* is the Chord of the Arch *a h n* of a great Circle, meaſuring the Angle *a* R *n*, by which the Point *a* appears removed by the two Reflections, to an Eye placed in the Center R. Therefore the Tranſlation, or apparent Change of Place of the Point *a* is meaſured by an Arch of a great Circle, whoſe Chord is to the Chord of the Arch A H N (equal to double the Inclination of the Specula) as the Sine complement of its Diſtance from the great Circle B A N is to the Radius.

From any Point C of the Circumference O B C draw the Chords C M and C *m*, to the ſame Side of the Point C, and equal to the Chords A N and *a n* reſpectively, draw the Radius R M, and from R and *m* draw R Q and *m* P, both perpendicular to C M, and cutting it in Q and P. R Q is the Sine complement, and C M double the Sine of half the Angle M R C, or A R N, or of the Angle of Inclination of the Specula. The little Arch M *m* will repreſent the Difference of the apparent Tranſlations of the Objects in A and *a*; and if it be very ſmall, may be looked on as a ſtrait Line, and the little mix'd Triangle M *m* P as a rectilinear one, which will be ſimilar to R M Q, becauſe R M is perpendicular to M *m* and

R Q

R Q to C M, and the Angles at Q and P right Angles. The Line C P may be taken as equal to C *m*, and M P as the Difference of the Lines C M and C *m*. Therefore the little Arch M *m* is to the Line M P nearly as R M to R Q: But C M (*i. e.* A N) was to C *m* (*i. e. a n*) as B R to *b r*, and the Difference M P of C M and C *m* to the Difference B D of B R and *b r* as C M to B R. Therefore M *m*, the Difference of the apparent Tranſlations, is to B D, the verſed Sine of the Diſtance B *b*, or to an Arch equal to it, in the compound Ratio of R M the Radius to R Q the Sine complement of the Angle of Inclination of the Specula, and C M double the Sine of the ſame to B R the Radius, *i. e.* as C M to R Q.

The Obſervation may be corrected by one eaſy Operation in Trigonometry, as will appear from the firſt Part of this Corollary, *viz.* by taking the half of the Angle obſerved, and then finding another Angle, whoſe Sine is to the Sine of that half, as the Sine complement of the Diſtance B *b* is to the Radius: This Angle doubled, will be the true Diſtance of the Objects. But as this Operation, though eaſy, will require the uſe of Figures, I rather choſe the Method of Approximation, becauſe by that the Obſerver, retaining in his Memory the Proportions of the Sines of a few particular Arches to the Radius, may eaſily eſtimate the Correction without Figures, when the Angle is not great, and by a Line of artificial Numbers and Sines, may always determine it with greater Exactneſs than will ever be neceſſary.

When the Angle obſerved is very near 180 Degrees, the Correction may be omitted; for then it will be

eaſy

eaſy to keep the Plane of the Inſtrument ſo near that of the before-mentioned great Circle as not to want any, if the Situation of that Circle be known: If it be not, the Obſerver, when he ſees the two Objects together, may turn the Inſtrument on the Axis of the Teleſcope, 'till he finds that Poſition of it by which he obtains the leaſt Angle; and this (if the Specula are ſet truly perpendicular to the Plane of the Inſtrument) will always happen when the Objects appear to coincide in the Line *g h*, as expreſſed in the third Fig. of *Tranſ.* No 420.

In Page 152 of the ſame, a Rule is given for finding to which Hand of the Obſerver the Object ſeen by Reflection ought to lie, but is reſtrained to the particular Form of the Inſtrument there deſcribed. The general Rule is, that when the Index is brought to the beginning of the Scale (*i.e.* to 0° when the Inſtrument is deſigned for Angles under 90°, or to 90° when it is deſigned for Angles from 90° to 180°) if then a Line be imagined to be drawn on it parallel to the Axis of the Teleſcope, or Line of Direction of the Sight, ſo as to point towards the Object ſeen directly; which ever way this Line is carried by the Motion of the Index along the Arch from 0° towards 90° in the firſt Caſe, or from 90° towards 180° in the ſecond, the ſame way the Object ſeen by Reflection ought to lie from that which is ſeen directly.

Erratum, Pag. 154. Line 24, read, *They may be either of Metal, or Glaſs Plates foil'd, having their two Surfaces*, &c.

II. Ephe-